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(54) METHOD AND DEVICE FOR MACHINING FISSILE OR FERTILE MATERIALS

(71) We, BELGONUCLEAIRE, S.A., a Belgian Company, of rue des Colonies 35, B — 1000, Brussels, Belgium, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to a method of and device for machining fissile or fertile materials and more particularly fuel pellets for nuclear reactors, which are formed from such materials and incompatible with coolants commonly used in machining operations.

Generally. the tolerances of size and shape of fuel pellets are such that a final machining of the pellets is required after sintering. In most cases the sintered pellets are ground to a required size and shape. However, in order to maintain the required accuracy of size and shape and in order that the mechanical and/or metallurgical properties of the pellet material are not substantially affected, it is necessary to cool the pellets during grinding or any final machining operation. Normally, cooling is effected by grinding the pellets in a stream of water which may or may not contain an oil or other such organic component.

The presence of water gives rise to a number of disadvantages, particularly when the pellet contains fissile material. Care must be taken to ensure that a critical quantity of fissile material in the water is not exceeded, the pellets must be dried after grinding and, after drying, control of the residual humidity of a pellet is required. Further, the coolant system must be a closed circuit to enable reclamation of the "ground-off" pellet material.

It is an object of this invention to overcome these disadvantages.

According to one aspect of this invention a method of machining fissile or fertile material comprises the step of cooling the material and/or the tool during machining, with a liquefied inert gas (as herein defined).

When the machining operation is a grinding operation, cooling may be effected by projecting a stream of the liquefied gas on to the grindstone and/or directly on to the material.

According to another aspect of this invention we provide a method of rectifying nuclear fuel pellets wherein pellets are introduced into a rectifier and cooled with the aid of an inert liquid gas (as herein defined) during their contact with an abrasive grindstone performing the rectification.

According to another aspect of this invention a device for machining a fissile or fertile material comprises an abrasive grindstone, means for applying to the material and/or the grindstone during machining a liquefied inert gas (as herein defined) and an aspiration system for removing waste material.

According to yet another aspect of this invention a method of grinding a nuclear fuel pellet comprises the step of cooling the pellet with a liquefied inert gas during contact with an abrasive grindstone.

According to a further aspect of this invention a device for rectifying nuclear fuel pellets comprises an abrasive grindstone, a driving wheel, a liquid inert gas (as herein defined) projection system and an aspiration system for rectification wastes.

In one embodiment of the invention the material is in the form of a nuclear fuel pellet and the grinding operation is effected on a centreless grinding machine.

The required rate of coolant flow is a function of the amount of material to be ground from the surface of a pellet and of the feed rate of a pellet through the grinding machine.

In this specification the term "inert gas" is intended to include any gas which does not react with either the pellet material or any of the materials used in the construction of the machine and tools used to carry out the final machining operation. Examples of such an inert gas are nitrogen and argon.

Preferably pellet material removed from a

pellet during, for example, grinding, is collected by an aspiration nozzle and separated from the inert gas coolant by a filter.

When the machine is a centreless grinding machine the aspiration nozzle conveniently is mounted beneath the pellet support or work rest.

The invention will now be described by way of example, with reference to the accompanying drawings, of which:—

Figure 1 is a schematic cross-section of a grinder, and

Figure 2 is a plan view of the grinder shown in Figure 1.

The figures show a centreless grinding machine having a grinding wheel 1 of ceramic abrasive material and a driving wheel 2 formed from synthetic rubber.

Fuel pellets 3, formed from a mixture of uranium oxide and plutonium oxide and having a diameter of 15 mm, are fed between the wheels 1 and 2 by a vibrating conveying trough 4.

The speed of rotation of the wheels 1 and 2 is respectively 2000 and 80 revolutions per minute and the speed at which the pellets are fed between the wheels is one meter per minute. In order to facilitate the feeding of a pellet to the space between the two wheels where it is supported upon a slider 6, the grinding wheel 1 is formed with a chamfer 5 as shown in Figure 2.

Coolant (in this case liquid nitrogen) stored in a tank 9, is sprayed on to the pellets by an adjustably mounted nozzle 7 and the rate of flow of coolant is controlled by a regulating valve 8.

An aspiration nozzle 10 mounted beneath the slider or work rest 6, is connected by a conduit 13 to a filter 11 which is in turn connected to a suction pump 12. The pump 12 applies suction to the nozzle 10 and thereby draws gas through the filter 11 so that waste pellet material ground from the surface of a pellet is collected in the filter 11 and may be recycled for use in compacting other pellets.

The following advantages are peculiar to the proposed rectification method:

1. Elimination of the cooling-water, resulting in simplification of the criticality problems;

2. Elimination of a purification device for water, in view of removing the rectification muds;

3. Elimination of the humidity of the sintered pellets, facilitating the fabrication cycle.

The grinding wheel 1 may be formed from any thermo setting material in which diamonds are embedded. Further pellets need not necessarily be fed to the machine by a vibratory device. A mechanical or pneumatic driver device may be used.

Although the machining of pellets using a liquefied inert gas as a coolant is particularly suited to the manufacture of nuclear fuel pellets, the method according to the invention may advantageously be used in the manufacture of other articles formed from materials which are incompatible with water or other known coolants.

WHAT WE CLAIM IS:—

1. A method of machining fissile or fertile materials comprising the step of cooling the material and/or the tool during machining with a liquefied inert gas (as herein defined).

2. A method according to claim 1 wherein the machining operation is a grinding operation and wherein the tool is a grinding wheel.

3. A method according to claim 2 wherein the material is in the form of a nuclear fuel pellet and wherein the machining operation is effected on a centreless grinding machine.

4. A method of grinding a nuclear fuel pellet comprising the step of cooling the pellet with a liquefied inert gas during contact with an abrasive grindstone.

5. A method according to claim 3 or 4 wherein the fuel pellet is formed from uranium oxide.

6. A method according to claim 3 or 4 wherein the fuel pellet is formed from plutonium oxide.

7. A method according to claim 5 or claim 6 wherein the liquefied inert gas is nitrogen.

8. A method according to any one of claims 2—7 including the step of collecting and separating the inert gas and waste material ground from the article.

9. A method for rectifying nuclear fuel pellets, wherein pellets are introduced into a rectifier and cooled with the aid of an inert liquid gas (as herein defined) during their contact with an abrasive grindstone performing the rectification.

10. A method according to claim 9 wherein the inert gas is liquid nitrogen.

11. A method according to claim 9 or claim 10 wherein the inert gas is projected onto the abrasive grindstone.

12. A method according to claim 9 or 10 wherein the inert gas is projected onto the pellets.

13. A device for machining a fissile or fertile material and comprising an abrasive grindstone, means for applying to the material and/or the grindstone during machining a liquefied inert gas (as herein defined) and an aspiration system for removing waste material.

14. A device according to claim 13 which is a centreless grinding machine.

15. A device according to claim 13 or claim 14 wherein the aspiration system com-

prises an aspiration nozzle operatively connected to a filter means and a suction pump wherein the aspiration nozzle is located to draw gas and waste material, ground from the material, to the filter for separation.

16. A device according to any one of claims 13 to 15 wherein the means for applying to the material and/or grindstone during machining the liquefied inert gas comprises pump means, regulating valve means and an adjustably mounted nozzle.

17. Device for rectifying nuclear fuel pellets comprising an abrasive grindstone, a driving wheel, a liquid inert gas (as herein defined) projection system and an aspiration system for rectification wastes.

18. A method of machining a fissile or fertile material substantially as herein described with reference to the accompanying drawings.

19. A device for machining a fissile or fertile material constructed and arranged substantially as herein described with reference to and as illustrated in the accompanying drawings.

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1297095 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

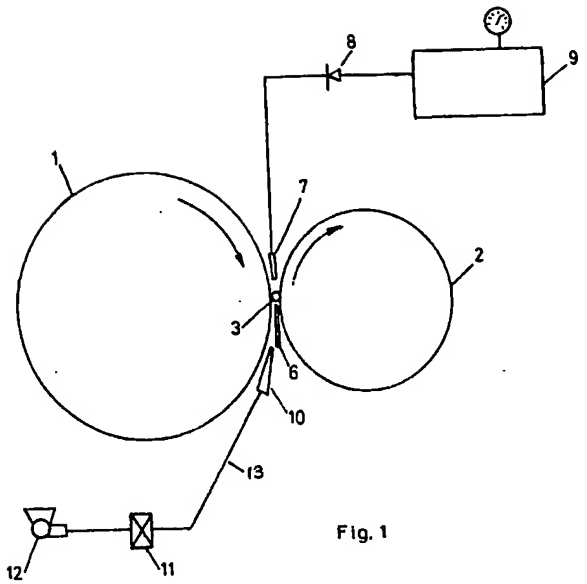

Fig. 1

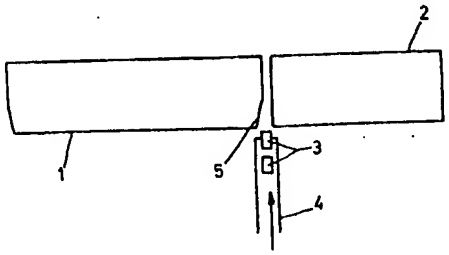

Fig. 2